

Place Recognition / Deep Learning

1 Numerical Exercises

1. Consider the clustering of the following points in \mathbb{R}^2 using the k -means clustering, where $k = 2$.

x_1	0	0
x_2	0	1
x_3	-1	2
x_4	2	0
x_5	3	0
x_6	4	-1

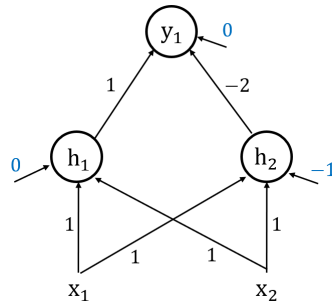
Table 1: Datapoints

- (a) In a first step, compute the squared distance matrix $D_{ij} = dist_{eucl.}(\mu_i, x_j)^2$ between the datapoints x_j and the initial cluster centers μ_i . Assume that the first and last datapoint are the initial centers.
- (b) Consider the following query image with the set of visual words Q and the image vocabulary V . Using the image retrieval method presented in the lecture, construct the voting array and state which image (A, B, C or D) is the closest to the query image.

$$Q = \{1, 2, 3, 4\}$$

$$V = \{1 = \{A, B\}, 2 = \{A, B, C\}, 3 = \{C\}, 4 = \{A, B, C, D\}\}$$

- (c) Consider the following MLP with the black numbers above the edges representing the weights and the blue numbers above the arrows the biases. All activations are ReLU function, i.e., $f(x) = \max(0, x)$. Compute the hidden activations h_1 and h_2 and output y_1 for the following inputs to the network.



- i. $x_1 = 0$ and $x_2 = 0$
- ii. $x_1 = 1$ and $x_2 = 0$
- iii. $x_1 = 0$ and $x_2 = 1$
- iv. $x_1 = 1$ and $x_2 = 1$
- v. For the above binary inputs, what function does this MLP approximate?